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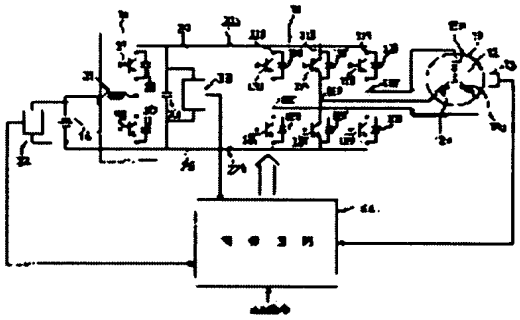
(54) DRIVER FOR MOTOR, AND ELECTRIC MOTORCAR

(57)Abstract:

PROBLEM TO BE SOLVED: To make the responsiveness of control approximately constant even if battery voltage changes, and get specified motor property.

SOLUTION: A chopper circuit 15 is interposed between a battery 14 and an inverter circuit 16. A motor 11 is driven by the inverter circuit 16. A battery voltage detecting circuit 32 is connected to the battery 14, and this driver is provided with an inverter circuit input voltage detecting circuit 33 on the input side of the inverter circuit 16. A control circuit 34 sets the loop gain of feedback control according to the battery voltage Vbat, and correts the loop gain so that the step-up chopper duty ratio and the inverter circuit input voltage Vdc may be in proportional relation, according to the ratio of the battery voltage Vbat to the inverter circuit input voltage Vdc at the time of boosting.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] It has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode. The drive circuit which an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element, The feedback control means which carries out feedback control of said motor, and the chopper circuit which is connected to juxtaposition in said drive circuit, and comes to have a switching element and a fly wheel diode, The reactor connected between the node of the switching element and fly wheel diode in this chopper circuit, and said dc-battery, The chopper control means to which said chopper circuit is made to carry out pressure-up actuation at the time of the need, A battery voltage detection means to detect the terminal voltage of said dc-battery, and a loop-gain setting means to set up the loop gain of the feedback control in the time of a non-pressure up according to the terminal voltage of the dc-battery detected by this battery voltage detection means, A drive circuit input voltage detection means to detect said drive circuit input voltage, A loop-gain amendment means to amend the loop gain of feedback control according to the dc-battery terminal voltage detected by said battery voltage detection means at the time of the pressure up by said chopper circuit, and the drive circuit input voltage detected by said drive circuit input voltage detection means, The driving gear of the motor which it comes to provide.

[Claim 2] A loop-gain amendment means is the driving gear of the motor according to claim 1 characterized by amending the loop gain of feedback control according to the ratio of the dc-battery terminal voltage detected by the battery voltage detection means, and the drive circuit input voltage detected by the drive circuit input voltage detection means.

[Claim 3] It has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode. The drive circuit which an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element, The feedback control means which carries out feedback control of said motor, and the chopper circuit which is connected to juxtaposition in said drive circuit, and comes to have a switching element and a fly wheel diode, The reactor connected between the node of the switching element and fly wheel diode in this chopper circuit, and said dc-battery, The chopper control means to which said chopper circuit is made to carry out pressure-up actuation at the time of the need, A battery voltage detection means to detect the terminal voltage of said dc-battery, and a loop-gain setting means to set up the loop gain of the feedback control in the time of a non-pressure up according to the terminal voltage of the dc-battery detected by this battery voltage detection means, The driving gear of the motor which comes to provide a boost chopper duty ratio setting means to set up a boost chopper duty ratio so that the relation to proportionality of the controlled variable and motor applied voltage which were calculated with said feedback control means may become.

[Claim 4] A chopper circuit connects the parallel circuit of a switching element and a fly wheel diode to a serial, and it is constituted so that both a pressure up and pressure lowering may be made to serve a double purpose. A chopper control means Are a time of supplying motorised power to a drive circuit, and an operation is made possible by making a chopper circuit into the chopper for pressure ups at the time of the pressure-up need. The driving gear of the motor according to claim 1 or 3 characterized by carrying out on-off control of said two switching elements so that an operation may be made possible as a pressure-lowering chopper at the time of the regeneration of a motor.

[Claim 5] The electric vehicle characterized by carrying the driving gear of a motor according to claim 1 or 3.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the driving gear and electric vehicle of a motor which change the direct current power of a dc-battery into alternating current power by the drive circuit, and were supplied to the motor.
[0002]
[Problem(s) to be Solved by the Invention] For example, the conventional example of the driving gear which drives the motor of an electric vehicle is shown in drawing 8 . While the direct-current bus-bars 2 and 3 are connected to forward [of a dc-battery 1], and a negative terminal, between this direct-current bus-bar 2 and 3, the drive circuit 6 which comes to carry out bridge connection of six transistor 4U 4W and 5U thru/or 5W is connected, and the output terminal of that drive circuit 6 is connected to the input terminal of a motor 7. In this case, since the direct current voltage of a dc-battery 1 is directly impressed to the drive circuit 6, output (rotational frequency) control of a motor 7 is performed by carrying out PWM control of the drive circuit 6.
[0003] By the way, the dc-battery 1 has the property that consist of a lead accumulator and a voltage drop becomes large according to the discharge current. For this reason, when you need a big output for a motor 7 like [at the time of start acceleration], a current will become large and the voltage drop of a dc-battery 1 will also become large. Moreover, a big difference is in the electrical potential difference of a dc-battery 1 in the discharge last stage immediately after charge. Thus, when the electrical potential difference of a dc-battery 1 changed, there were the following problems.
[0004] The output control of a motor 7 carries out PWM control of the drive circuit 6, and since it performs by controlling the electrical potential difference impressed to a motor 7, if battery voltage changes, the responsibility will also change. That is, responsibility differs in the early stages of acceleration, the acceleration last stage, and the early stages of charge and the discharge last stage. Since the acceleration time becomes long, a loop gain is raised and it is made to carry out a response, since the voltage drop is large at the time of start acceleration early especially, and control will become unstable if a loop gain is raised too much.
[0005] Moreover, when a motor 7 is designed based on the rated voltage of a dc-battery 1, a predetermined motor property is no longer acquired in the discharge last stage. But a motor 7 will become large if it designs based on the electrical potential difference of the dc-battery discharge last stage.
[0006] This invention is made in view of the above-mentioned situation, and the purpose is to offer the driving gear and electric vehicle of a motor with which a predetermined motor property is acquired while being able to fix responsibility of control mostly, even if it changes battery voltage.
[0007]
[Means for Solving the Problem] The driving gear of the motor of claim 1 has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode. The drive circuit which an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element, The feedback control means which carries out feedback control of said motor, and the chopper circuit which is connected to juxtaposition in said drive circuit, and comes to have a switching element and a fly wheel diode, The reactor connected between the node of the switching element and fly wheel diode in this chopper circuit, and said dc-battery, The chopper control means to which said chopper circuit is made to carry out pressure-up actuation at the time of the need, A battery voltage detection means to detect the terminal voltage of said dc-battery, and a loop-gain setting means to set up the loop gain of the feedback control in the time of a non-pressure up according to the terminal voltage of the dc-battery detected by this battery voltage detection

means, A drive circuit input voltage detection means to detect said drive circuit input voltage, A loop-gain amendment means to amend the loop gain of feedback control according to the dc-battery terminal voltage detected by said battery voltage detection means at the time of the pressure up by said chopper circuit, and the drive circuit input voltage detected by said drive circuit input voltage detection means, It is provided and constituted.

[0008] In the driving gear of the motor of this claim 1, it is having minded the boost chopper circuit between the dc-battery and the drive circuit, and even if battery voltage falls, a predetermined motor property is acquired. Moreover, since it was made to change the loop gain of feedback control according to battery voltage, even if battery voltage changes, the response of feedback control becomes fixed. Moreover, since the loop gain of feedback control is amended according to dc-battery terminal voltage and drive circuit input voltage at the time of the pressure up by the chopper circuit, it becomes controllable [which it was stabilized at the time of chopper control].

[0009] The driving gear of the motor of claim 2 has the description at the place where a loop-gain amendment means sets up the loop gain of feedback control according to the ratio of the dc-battery terminal voltage detected by the battery voltage detection means, and the drive circuit input voltage detected by the drive circuit input voltage detection means. In this configuration, since the loop gain of feedback control is set up according to the ratio of dc-battery terminal voltage and drive circuit input voltage at the time of the pressure up by the chopper circuit, feedback control is further stabilized at the time of chopper control.

[0010] The driving gear of claim 3 motor has one or more arms which come to connect with a serial two switching elements which have a fly wheel diode. The drive circuit which an input terminal is connected to a dc-battery, and an output terminal is connected to a motor, and carries out energization control of said motor by turning on and off of said switching element, The feedback control means which carries out feedback control of said motor, and the chopper circuit which is connected to juxtaposition in said drive circuit, and comes to have a switching element and a fly wheel diode, The reactor connected between the node of the switching element and fly wheel diode in this chopper circuit, and said dc-battery, The chopper control means to which said chopper circuit is made to carry out pressure-up actuation at the time of the need, A battery voltage detection means to detect the terminal voltage of said dc-battery, and a loop-gain setting means to set up the loop gain of the feedback control in the time of a non-pressure up according to the terminal voltage of the dc-battery detected by this battery voltage detection means, It has a boost chopper duty ratio setting means to set up a boost chopper duty ratio so that the relation to proportionality of the controlled variable and motor applied voltage which were calculated with said feedback control means may become, and is constituted.

[0011] In the driving gear of the motor of this claim 3, it is having minded the boost chopper circuit between the dc-battery and the drive circuit, and even if battery voltage falls, a predetermined motor property is acquired. Moreover, since it was made to change the loop gain of feedback control according to battery voltage, even if battery voltage changes, the response of feedback control becomes fixed. Since a boost chopper duty ratio is set up so that the relation to proportionality of the controlled variable and motor applied voltage which were calculated with the feedback control means may become at the time of the pressure up by the chopper circuit, control stabilized at the time of chopper control can be performed further again.

[0012] As for the driving gear of the motor of claim 4, a chopper circuit connects the parallel circuit of a switching element and a fly wheel diode to a serial. It is constituted so that both a pressure up and pressure lowering may be made to serve a double purpose. A chopper control means Are a time of supplying motorised power to a drive circuit, and an operation is made possible by making a chopper circuit into the chopper for pressure ups at the time of the pressure-up need. It has the description at the place which carries out on-off control of said two switching elements so that an operation may be made possible as a pressure-lowering chopper at the time of the regeneration of a motor. In this configuration, operation that a big regeneration current does not flow to a dc-battery side is acquired.

[0013] The electric vehicle of claim 5 carries the driving gear of the motor of claims 1 or 3. The transit which could plan the motor stabilized by this even if there was voltage variation of a dc-battery, and was stabilized is attained.

[0014]

[Embodiment of the Invention] Hereafter, it explains about the 1st example which applied this invention to the electric vehicle, referring to drawing 1 thru/or drawing 5 . In drawing 1 which shows a whole configuration, the brushless motor 11 is carried in the electric vehicle as a motor for transit, and this is equipped with the stator 12 which has the stator coils 12U, 12V, and 12W of two or more phases, for example, a three phase circuit, Rota which is not illustrated, and a position transducer 13. Moreover, the dc-

battery 14 which consists of a lead accumulator and which can be charged is carried in this electric vehicle, and it is given to the inverter circuit 16 as a drive circuit through the chopper circuit 15 where the DC power supply from this dc-battery 14 constitute a boost chopper circuit and a pressure-lowering chopper circuit, and it is changed into AC power supply by this inverter circuit 16, and said brushless motor 11 is supplied.
[0015] Three-phase-circuit bridge connection of the transistors 17U, 17V, and 17W of a six switching element slack NPN form, and 18U, 18V and 18W was carried out, it was constituted, and fly wheel diodes 19U, 19V, and 19W, and 20U, 20V and 20W are connected between each collector emitter, with the above-mentioned inverter circuit 16 has three arms 21U, 21V, and 21W. And the input terminals 22a and 22b of this inverter circuit 16 are connected to the direct-current bus-bars 24 and 25 to which the capacitor 23 was connected between lines, and output terminals 26U, 26V, and 26W are connected to one terminal each of the stator coils 12U, 12V, and 12W of a brushless motor 11. In addition, each other end child of stator coils 12U, 12V, and 12W is connected in common.
[0016] A chopper circuit 15 connects the transistors 27 and 28 as a switching element to a serial, and is constituted, and fly wheel diodes 29 and 30 are connected between each collector emitter. The collector of a transistor 27 is connected to the direct-current bus-bar 24, and the emitter is connected to the positive terminal of a dc-battery 14 through the reactor 31 while connecting with the collector of a transistor 28. Moreover, the emitter of a transistor 28 is connected to the negative terminal of the direct-current bus-bar 25 and a dc-battery 14.
[0017] It connects between the forward negative terminals of a dc-battery 14, and the battery voltage detector 32 as a battery voltage detection means detects the terminal voltage of a dc-battery 14. Moreover, it connects with the direct-current bus-bars 24 and 25, and the inverter circuit input voltage detector 33 as a drive circuit input voltage detection means detects inverter circuit input voltage.
[0018] A feedback control means, a chopper control means, a loop-gain setting means, and the loop-gain amendment means slack control circuit 34 are constituted by the subject in a microcomputer, and each output terminal of the battery voltage detector 32, the inverter circuit input voltage detector 33, and a position transducer 13 and the rate command output terminal from the transit control section (not shown) of an electric vehicle are connected to the input port. Moreover, each output port is connected to the base of the transistors 17U, 17V, 17W, 18U, 18V, and 18W of an inverter circuit 16, and the transistors 27 and 28 of a chopper circuit 15, respectively.
[0019] Now, an operation of the above-mentioned configuration is described. A control circuit 34 switches the case where a chopper circuit 15 is made to act as a boost chopper, the case where it is made to act as a pressure-lowering chopper, and the case where the operation of both is not operated.
[0020] That is, feedback control of the control circuit 34 is carried out so that it may also have the function to detect rotational speed based on the signal from said position transducer 13 and the rotational speed of a motor 11 and the rate command from the transit control section (not shown) of an electric vehicle may be made in agreement. In this case, accommodation control of the loop gain of an PWM duty ratio and the rate of a pressure up by the chopper circuit 15, or feedback control is carried out, and as a control gestalt, when it divides roughly, there are the following three.
[0021] (a) Since the applied voltage to a motor 11 is also low and ends in this case when a rate command is comparatively low (when below the usual output (rotational speed and torque which are used frequently) of a motor 11 may be used), turn off both the transistors 27 and 28 of a chopper circuit 15, and the direct current voltage of a dc-battery 14 considers as the input voltage of an inverter circuit 16. At this time, the above-mentioned PWM duty ratio is suitably computed at the time of inverter control, and the applied voltage to a motor 11 is controlled proper. Moreover, it sets up so that the loop gain of feedback control may also be mentioned later.
[0022] (b) Moreover, with the usual output of a motor 11, although the rotational speed according to a rate command is obtained, when almost good, turn off the transistors 27 and 28 of a chopper circuit 15 in it, and the direct current voltage of a dc-battery 14 considers as the input voltage of an inverter circuit 16. Let applied voltage to a motor 11 be the electrical potential difference of dc-battery 14 itself at this time, using the above-mentioned PWM duty ratio as 100% at the time of above-mentioned inverter control.
[0023] (c) When beyond the usual output of a motor 11 is required, while it turns on the transistor 28 of a chopper circuit 15 although the rotational speed according to a rate command is obtained, and making it act on it as a boost chopper further, it amends so that the loop gain of feedback control may be mentioned later.
[0024] He can understand the contents of control of these (a), (b), and (c) from the flow chart of drawing 2 . That is, a control circuit 34 performs control shown in the flow chart of drawing 2 . Step S1 to the step S5 is loop-gain setup / amendment processing, and step S15 is PID-control processing from step S6.
[0025] In loop-gain setup / amendment processing, battery voltage Vbat detected with the battery voltage

detector 32 is read (step S1), and a loop gain G is set up according to this battery voltage Vbat (step S2). This loop gain G is called for so that it may become G=GrefxVref/Vbat to reference voltage Vref and the criteria loop gain Gref. That is, it sets up so that the value which applied a loop gain G and motor applied voltage may become fixed.

[0026] Next, the electrical potential difference Vdc detected with the inverter circuit input voltage detector 33 is read (step S3), and battery voltage Vbat is compared with the inverter circuit input voltage Vdc (step S4). if the meaning of this comparison is Vbat<Vdc -- a pressure up -- it turns out that it turns out that it is working, and pressure-up actuation will not have been carried out if it is Vbat=Vdc

[0027] a pressure up -- if working, it will shift to step S5 and the loop gain G set up at step S2 will be amended according to the rate (Vdc/Vbat) of a pressure up. Namely, in this example, it has memorized as data experimentally in quest of the optimal scale factor alpha to the loop gain to the rate of a pressure up beforehand (the relation between the rate of a pressure up and this scale factor alpha is shown in drawing 4). The scale factor alpha to the loop gain corresponding to this rate of a pressure up is accessed, it takes advantaging of the loop gain G (a concrete value being set to G1) which set up this scale factor alpha at step S2, and the last loop gain G (G=G1xalpha) is obtained. Here, although the relation between a general chopper duty ratio and motor applied voltage is shown in the broken line A of drawing 3 , this scale factor alpha indicates drawing 4 that the value which hung the last loop gain becomes the relation between a chopper duty ratio and motor applied voltage with proportionality. That is, the above-mentioned scale factor alpha is set up so that a chopper duty ratio and motor applied voltage may serve as proportionality shown as the continuous line B of drawing 3 . This last loop gain is used for the feedback control which performs pressure-up control of a chopper circuit 15.

[0028] In addition, if it is judged in step S4 that it is not among a pressure up, there will be no loop-gain amendment of step S5, and the loop gain set up at step S2 will be used for the feedback control performed by PWM control of the next inverter circuit 16.

[0029] In PID-control processing, a rate command is read (step S6), and the rotational speed of a motor 11 is calculated based on the detecting signal from a position transducer 13 (step S7), and it asks for the deflection of rotational speed (step S8). Next, proportionality data processing (step S9), integration operator processing (step S10), and derivation processing (step S11) are performed from the deflection for which it asked, each processing value is added, and a controlled-variable slack control value is calculated (step S12). As shown in drawing 5 from this control value, an PWM duty ratio and a boost chopper duty ratio are determined (step S13).

[0030] Then, the energization timing signal over transistor 17U of an inverter circuit 16 17W and 18U thru/or the on-off timing of 18W, or the energization timing (a transistor 27 is off) of the transistor 28 of a chopper circuit 15 is created (step S14), and a base signal is given to that energization timing to each transistor 17U 17W and 18U thru/or 18W, or a transistor 28, and on-off control of these transistors is carried out (step S15).

[0031] In step S15, the following control is specifically performed from this step S13. That is, a chopper circuit 15 carries out feedback control of the motor 11 by PWM duty ratio control for not using it (transistors 27 and 28 being turned off), and the loop gain uses the loop gain set up at step S2 so that 50% may understand a control value from drawing 5 . Since it was made for what applied a loop gain and motor applied voltage to become fixed even if the electrical potential difference of a dc-battery 14 fell at the time of such operation, responsibility of feedback back control can be set constant.

[0032] Moreover, if a control value exceeds 50%, an PWM duty ratio will be made into 100%, the boost chopper duty ratio by the chopper circuit 15 is controlled, and feedback control of the motor 11 is carried out. The loop gain at this time uses the loop gain amended at step S5. Since a loop gain is set up so that a boost chopper duty ratio and the inverter circuit input voltage Vdc may serve as proportionality according to the ratio of battery voltage Vbat and the inverter circuit input voltage Vdc at the time of such operation, feedback control does not become unstable.

[0033] By repeating and performing control shown in this flow chart for every predetermined time, predetermined alternating voltage is supplied to a motor 11, and motor rotational speed is controlled to predetermined. Moreover, a control circuit 34 is a basis in the condition of having made the transistor 28 of a chopper circuit 15 off, turns on and off and has a transistor 27 to predetermined energization timing, and makes a chopper circuit 15 act as a pressure-lowering chopper at the time of the regeneration of a motor 11.

[0034] According to such this example, the loop gain of feedback control is set up according to battery voltage Vbat, and since it was made for what applied this loop gain and motor applied voltage to become fixed, even if battery voltage Vbat falls, the responsibility of feedback back control can be set constant. Moreover, since the pressure up of the input voltage of the drive circuit 16 can be carried out in a chopper

circuit 15 even if the electrical potential difference of a dc-battery 14 falls, a predetermined motor output can be obtained.
[0035] Moreover, since it turns on and off and has a transistor 27 to predetermined energization timing by the basis in the condition of having made the transistor 28 of a chopper circuit 15 off, at the time of the regeneration of a motor 11 and was made to make a chopper circuit 15 act as a pressure-lowering chopper, a big regeneration current does not flow to a dc-battery side.
[0036] Since a loop gain is amended so that a boost chopper duty ratio and the inverter circuit input voltage Vdc may serve as proportionality according to the ratio of battery voltage Vbat and the inverter circuit input voltage Vdc especially at the time of a pressure up, stabilization of feedback control can be attained.
[0037] Even if [whose this invention is / like the 2nd example shown in drawing 6 and drawing 7], it is good. That is, from the control value which skipped and computed step S3 thru/or step S5 in the 1st above-mentioned example (that is, ** which does not carry out amendment processing of the loop gain), an PWM duty ratio and a boost chopper duty ratio (especially boost chopper duty ratio) may be set up like drawing 6 , and you may control to become proportionality as a control value and motor applied voltage show drawing 7 (this is equivalent to a boost chopper duty ratio setting means). Even if such, stabilization of feedback control can be attained.
[0038] In addition, this invention may be changed as follows. That is, although the control circuit containing a microcomputer constituted the control means from each above-mentioned example, this may be constituted using an arithmetic circuit and an adder circuit. Moreover, as feedback control, it may not be restricted to speed control, but a torque control and current control are sufficient. As a motor, an induction motor, 2 phase motor, a DC motor with a brush, the Li RAKUTANSU motor, etc. may be used. Moreover, as a drive circuit, IGBT, FET, and a thyristor may be used as a switching element in addition to a transistor that there should just be one or more arms.
[0039]
[Effect of the Invention] This invention can acquire the following effectiveness so that clearly from the above explanation. It is having minded the boost chopper circuit between the dc-battery and the drive circuit in the driving gear of the motor of claim 1. Since a predetermined motor property can be acquired and it was made to change the loop gain of feedback control according to battery voltage even if battery voltage fell Since the response of feedback control becomes fixed and the loop gain of feedback control is further amended according to dc-battery terminal voltage and drive circuit input voltage at the time of the pressure up by the chopper circuit even if battery voltage changes, it becomes controllable [which it was stabilized at the time of chopper control].
[0040] In the driving gear of the motor of claim 2, since the loop gain of feedback control is set up according to the ratio of dc-battery terminal voltage and drive circuit input voltage at the time of the pressure up by the chopper circuit, feedback control is further stabilized at the time of chopper control.
[0041] It is having minded the boost chopper circuit between the dc-battery and the drive circuit in the driving gear of the motor of claim 3. Since a predetermined motor property can be acquired and it was made to change the loop gain of feedback control according to battery voltage even if battery voltage fell Even if battery voltage changes, the response of feedback control becomes fixed. Since a boost chopper duty ratio is set up so that the relation to proportionality of the controlled variable and motor applied voltage which were calculated with the feedback control means may become at the time of the pressure up by the chopper circuit, control stabilized at the time of chopper control can be performed further again.
[0042] In the driving gear of the motor of claim 4, a big regeneration current does not flow to a dc-battery side. Since the electric vehicle of claim 5 carries the driving gear of the motor of claims 1 or 3, the transit of it which could plan the motor stabilized even if there was voltage variation of a dc-battery, and was stabilized is attained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The electrical diagram showing the 1st example of this invention
[Drawing 2] The flow chart which shows the contents of control
[Drawing 3] Drawing showing the relation between a boost chopper duty ratio and motor applied voltage
[Drawing 4] Drawing showing the relation between the rate of a pressure up, and the scale factor alpha of a loop gain
[Drawing 5] Drawing showing the relation between a control value and a duty ratio
[Drawing 6] The drawing 5 equivalent Fig. showing the 2nd example of this invention
[Drawing 7] Drawing showing the relation between a control value and motor applied voltage
[Drawing 8] The drawing 1 equivalent Fig. showing the conventional example
[Description of Notations]
In 11, a brushless motor and 13 a dc-battery and 15 for a position transducer and 14 A chopper circuit, 16 An inverter circuit (drive circuit), 17U, 17V, 17W and 18U, A transistor (switching element), 19U, 19V, 18V and 18W 19W, and 20U, 20V and 20W A fly wheel diode, 21U, An arm, and 27 and 28 21V and 21W A transistor (switching element), 29 and 30 a reactor and 32 for a fly wheel diode and 31 A battery voltage detector (battery voltage detection means), 33 shows an inverter circuit input voltage detector (drive circuit input voltage detection means), and 34 shows a control circuit (a feedback control means, a chopper control means, a loop-gain setting means, loop-gain amendment means).

[Translation done.]

* NOTICES *

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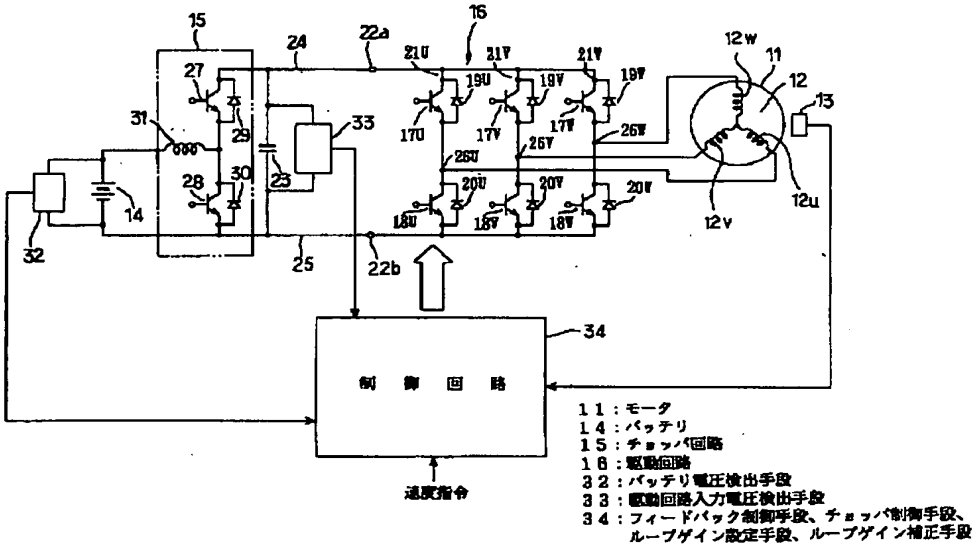
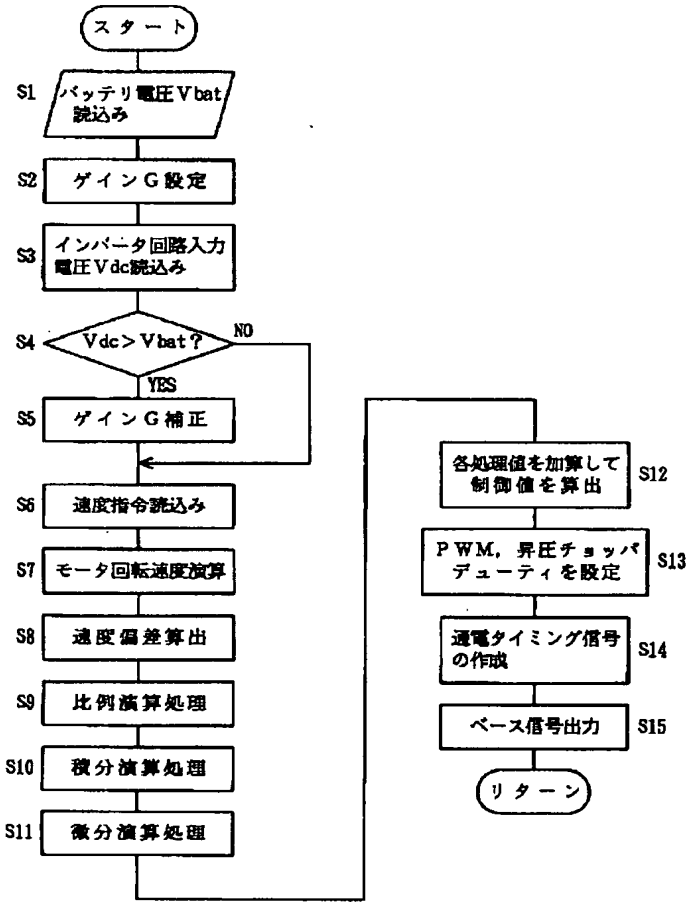
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

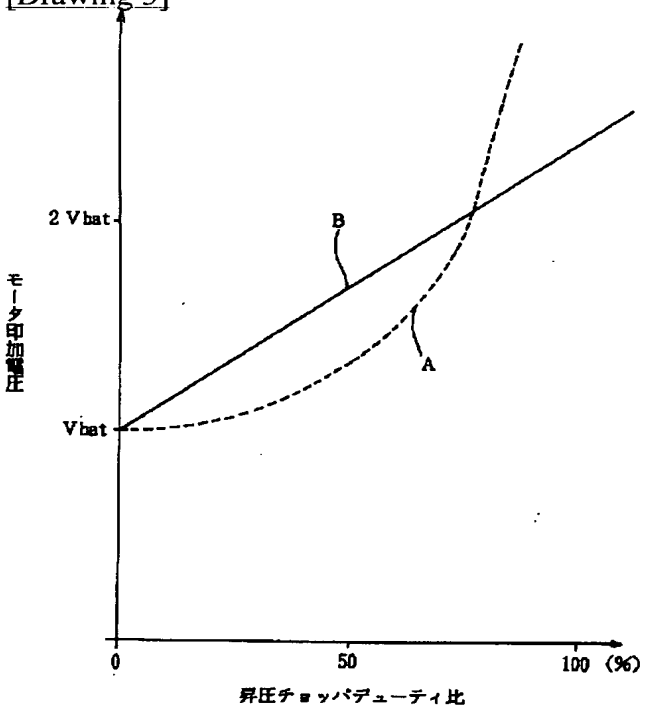
[Drawing 1]



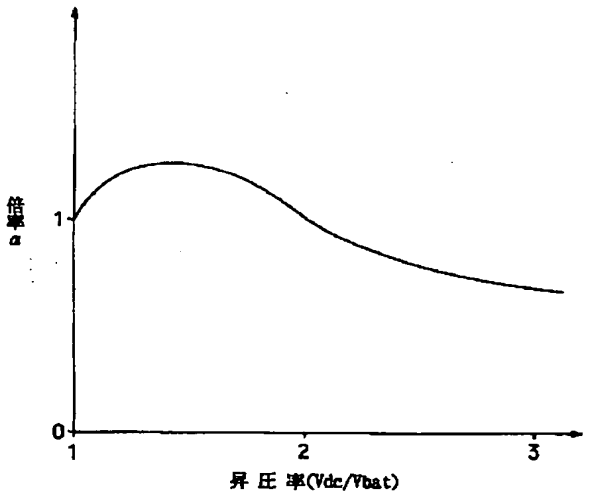
[Drawing 2]



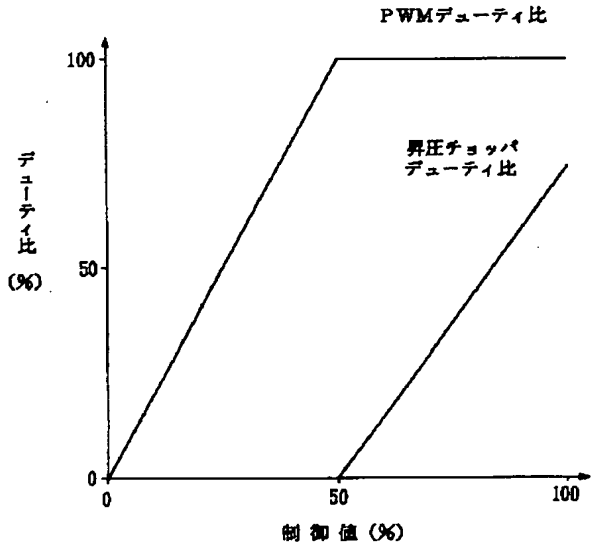
[Drawing 3]



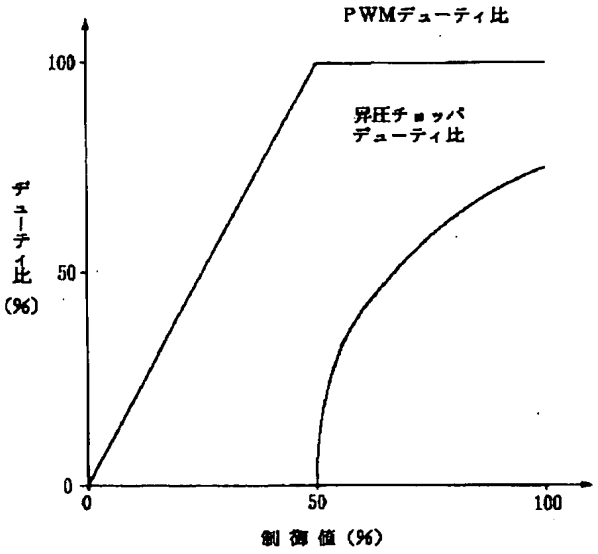
[Drawing 4]



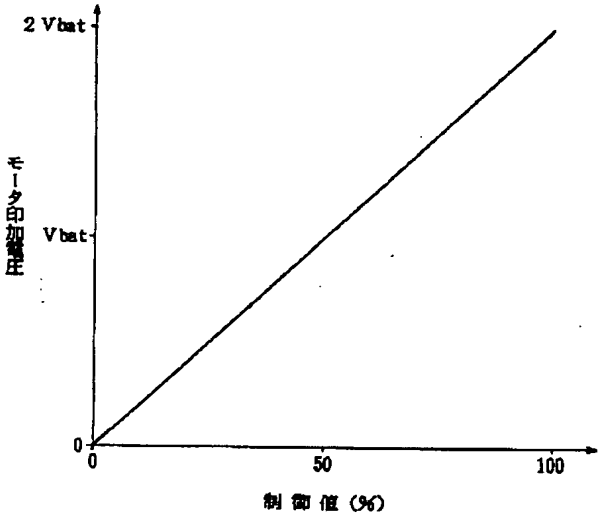
[Drawing 5]



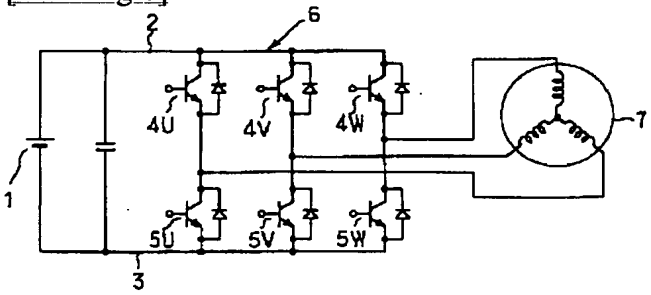
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]